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BULLETIN NO. 154

WHAT IS THE MATTER WITH THE ELMS IN ILLINOIS?

By STEPHEN A. FORBES
STATE ENTOMOLOGIST

URBANA, ILLINOIS, FEBRUARY, 1912

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WHAT IS THE MATTER WITH THE ELMS IN ILLINOIS?

By STEPHEN A. FORBES, STATE ENTOMOLOGIST

(Plates I to VI, and Figures 1 to 4)

The American white elm is doubtless the favorite shade tree thruout Illinois. It is especially valued for its broad and ample shade, its fairly rapid growth, its usual freedom from offensive insects, and its stout resistance to injury by wind storms and sleet; and it is universally admired, also, for its majestic yet graceful form, its picturesque profile, and the irregular, cloudlike masses of its foliage. It is particularly well adapted to streets, boulevards, and park drives; and an avenue of giant elms whose lateral branches arch broadly upwards to meet and mingle overhead is one of the noblest products of the landscape gardener's art.

I especially regret, therefore, to have to call general attention to a fatal affection of this tree now prevailing over a large part of southern Illinois, similar to, and apparently identical with, one which destroyed many elms in the central part of the state some thirty years ago. The character, extent, and cause of this destruction are such as to make it plain either that the elm must receive much more intelligent and assiduous care and treatment than it has heretofore had in this state, or that it must yield its place to some tree more hardy under conditions which it has itself failed to support.

Description of the Difficulty

The elm disease (if such it may be called) now prevalent, is first noticed from early summer to autumn—the leaves, first on the terminal twigs and later on the larger branches, ceasing their growth, turning brown, and finally falling. (See Plates I to IV.) This loss is presently followed by the death of the branches themselves, as is shown the following spring when the rest of the tree leaves out. Usually the higher branches are first affected, but the whole top soon seems to blight, and in a year or two the tree is dead. Sometimes this process is greatly shortened, and scores of

trees may perish within a single year after the first effects are noticed; and sometimes, on the other hand, it is greatly lengthened, extending thru five or six years, and, in mild cases, even ending in recovery. Altho there may be no definite sign of insect injury anywhere, it is most commonly the case that a thoro search of the trunk and larger branches will show patches of dead bark under which there are two or more kinds of burrowing insect larvæ, or borers. The roots of these trees are often affected somewhat as the branches are; that is, the smaller, terminal, so-called feeding roots die and dry up progressively, the process extending to the larger roots and the base of the trunk.

A TYPICAL CASE

The condition of the roots of trees so affected is well shown by the report of Mr. Lindley M. Smith, my field assistant for southern Illinois, who visited Du Quoin, Perry county, in July of the current year for an examination of elms reported to be dead or dying. This visit was in pursuance of a letter addressed to me by Mr. E. E. Jacobs, mayor of the town, who says, under date of July 8: "At the time the city of Du Quoin was laid out, some fifty years ago, our streets were lined with elm trees. These trees have gotten along nicely up to the present summer, but now there are probably a hundred and fifty trees dead or dying." Mr. Smith reports, July 14: "The elms are in very bad condition, and there are many dead or dying ones all over town. The round-headed borers [Fig. 1] are very thick under the bark on these dying trees, and the people in general seem to suppose that the borers are the cause of all of the damage. I dug out some of the main roots on seven large trees, and while many of the roots were still green for a few feet from the base, I invariably found that the little feeding roots were dead. In some cases the smaller roots had apparently been dead for several days, or perhaps weeks, as they were all discolored and some were almost rotten. We dug one tree out so that all of the roots could be examined. The outer ends of all the roots on this tree were dead, tho some of the main roots were still alive, and the leaves were not yet quite all dead. The tree had no taproot, all the roots spread out from the base of the tree, and none of them were very far beneath the surface. I found no sign of insect work on the roots, but most of the latter simply looked as if they had dried up. The ground was very dry, as there has been no rain that would wet down to the tree roots since some time in April." Similar conditions were found by Mr. Smith at Carbondale, where one tree was dug up, together with a number of roots

of other trees, on the campus of the Normal School; all the small feeding roots of these trees were dead, altho there was nothing about them to indicate injury by insects.

DISTRIBUTION OF THE INJURY

Practically identical reports of injury have been received this year, either from my own assistants or from office correspondents, from Cairo, Carbondale, Centralia, Clayton, Du Quoin, Edwardsville, Fairfield, Galatia, McLeansboro, Mt. Vernon, Quincy, Robinson, Sumner, and Vandalia—fourteen towns scattered thru thirteen counties of southern and western Illinois. Doubtless a critical examination of elm trees in towns and on private premises elsewhere would disclose an even more general occurrence of this trouble.

As none of the cases reported were from woodlands, but all were those of more or less isolated trees growing under artificial conditions, I have taken some pains to ascertain whether woodland elms were similarly affected. One of my assistants, Mr. Wesley P. Flint, made in 1909-10 a practically complete reconnaissance of all the forests of southern and western Illinois, including high lands and bottom lands, hills and plains, and the extremes of the state from Jo Daviess to Alexander counties. His object was to make a comprehensive study of insect injuries to forest trees and timber products in this state. In reply to my special inquiry he says: "I have not found elms dying in any numbers in any forest tract that I have examined in the state. This, of course, does not apply to stands of scattered trees around which the ground has been cultivated." Mr. Smith, who was especially instructed to inspect woodland trees about Du Quoin for a comparison of their condition with those in that town itself, reports that he saw a hundred and fifty elms in the woodlands along Reese Creek and Little Muddy Creek bottoms, but found none that were dying, and none that had died during the present summer, altho a few had perished from some cause at some time within the last three years.

The present difficulty with the elm in the southern part of the state is thus clearly one which is virtually limited to trees growing outside the forests, and usually under conditions more or less artificial to the tree—sometimes extremely so, where, for example, the elms are standing in a closely clipped turf beside a paved street.

A KENTUCKY INSTANCE

All the facts in my possession indicate that our Illinois elm disease is identical with one described in 1899 by Professor H.

Garman, Entomologist and Botanist of the Agricultural Experiment Station of Kentucky.* "Beginning," he says, "in 1892, and continuing with greater or less frequency ever since, complaints have reached me concerning a diseased condition of elm trees in this State. * * * Previous to 1892 there is every probability that the trouble was under way. It was observed in Massachusetts in 1847, and in Illinois in 1883. * * *

"The first discernible evidence of disease is a loss of the leaves at the ends of twigs, often at the tops of the trees. As the trouble extends towards the trunk, the foliage gradually drops from other parts until finally the tree stands bare. [Plates I to IV.] The fallen leaves may show no mark of insect work, certainly none that could cause them to let go their hold on the branches, and the only thing abnormal about them is a discoloration, sometimes present, like that due to the blight fungus of potatoes, the tips or side regions being more or less extensively black."

An Earlier Illinois Case

As already intimated, what seems to have been a similar trouble with the elms prevailed some time since in the central part of this state. It was in 1883, in fact—the first year of my service as State Entomologist of Illinois—that this matter first came to my notice; and during that and the three following years I studied the diseased elms with considerable care at Normal, Bloomington, and Champaign, publishing a short article on the subject in my third entomological report.† I was aided in this work by Professor Garman, who was at that time in my office; and he has had, consequently, an opportunity to compare the Illinois disease with that studied by him even more thoroly in Kentucky.

The Present Situation

My attention was first and most forcibly called to the present situation by a letter addressed to the University of Illinois in 1907 by Hon. John M. Rapp, of Fairfield, in Wayne county, and referred to my office for reply. In this letter he says: "We in this city are troubled with something that is causing the death of the elm shade trees. The matter seems to be growing worse each year. Some of the largest and finest trees have died, and the trouble does not seem to be confined entirely to the oldest and largest trees." In

*"The Elms and Their Diseases." Bull. 84, Ky. Agr. Exper. Station.

†Insects Injurious to the Elm. 14th Rep. State Ent. Ill., p. 112.

a later letter he says: "The elm trees, not only in this city, where they have been our chief shade tree, but in the surrounding country, are dying from some disease that is a mystery to our people. There is apparently no disease of the leaf—no web formed—but the leaves begin to dry up and to die, and finally, in a few months, the tree is dead. A number of the finest shade trees in the city have gone that way. There are many that now show evidences of the disease."

In consequence of this information I sent to Fairfield in the fall of 1907 Mr. H. E. Hodgkiss, an entomological assistant in my office at the time. As the primary cause of the disease seemed a matter of doubt, and might possibly be a fungous infection, or even cultural conditions merely, Mr. Hodgkiss was accompanied on his trip by Professor T. J. Burrill, of the University of Illinois, who kindly consented to assist us in the solution of the problem. After a thoro examination of several dead and dying trees in and about Fairfield these gentlemen came to the conclusion that the cause was a complex one, but differed in judgment as to the primary factor, Professor Burrill believing it to be the round-headed borer of the elm (*Saperda tridentata,* Fig. 1), which was abundant under the bark of most of the injured trees, and Mr. Hodgkiss concluding, on the other hand, that the original difficulty was in the roots.

CAUSES OF THE INJURY

The condition of the roots described above by Mr. Smith and a general infestation of the trunk and larger branches by borers, are found together at the same time and place, and usually in the same trees. The well-known disposition of the borers generally, and especially of the elm-tree borer, to infest first and most freely trees already suffering from some other cause, adds to our uncertainty concerning the share which these two causes may take in the destruction of our elms. It is probable that sometimes one is primary, and sometimes the other. The root injury may come to a tree already infested by borers, or the borers may come to infest a tree already affected at the roots, each injury intensifying the other, and both together destroying trees which might survive either alone. Even elm trees in the forest are more or less infested by the round-headed borer and other insects of similar habit. Mr. Flint reports, for example, that in his inspection of woodlands, he found this borer abundant in dying trees thruout the state, and the larva of the elm curculio (*Magdalis armicollis*, Fig. 3, 4) even more abundant in the northern counties. Small bark-beetles were

also very common in the bark of both dead trees and those otherwise healthy.

The elm in its natural habitat grows in a loose and shaded soil composed of leaf mold to a considerable depth, and does not root deeply. (See Plate VI.) If other trees and the underbrush which afford more or less protection to the elm roots are cut away, and especially if the land is pastured and the soil thus packed, or if, as in the city, the root system is cramped in earth sometimes permeated by escaping gas, too closely packed, unmulched, and unnaturally drained, and exposed for long summer periods to the hot glare reflected from the paved streets, the leaves of the tree in the meantime being constantly exposed to gas and smoke, and covered for weeks with dust from the street, we have an environment for this tree as unnatural as it would be possible to make it and permit the tree to live at all. The feeding roots are thus exposed to drouth, and sometimes remain for weeks at a time about as dry as the dust of the street. The soil is exhausted of plant food, and nothing is done to renovate it. The tree is starved and weakened, the uppermost twigs begin to die, and insects, instinctively attracted to the weaker trees, come in and finish the work. Their injury, at first scarcely perceptible, serves merely to accelerate the decline of the tree, but sometimes, unfavorable conditions having reached a temporary climax, the work of the borers, stimulated rather than retarded by such conditions, quickly overwhelms the tree, girdling its trunk and killing it as if by a sudden stroke.

Professor Garman is sure that in Kentucky insects were not the primary cause of the wide-spread loss of elm trees in 1899 and the years preceding. His discussion of conditions and effects is so instructive and convincing that I quote from it at length.

"The white elm," he says, "has a peculiar way of sending its main roots out close to the surface of the ground. Sometimes a root upon which a tree chiefly depends is covered in places with less than two inches of soil. Roots after leaving the base of the trunk actually turn toward the surface, where they extend for long distances in the rich surface soil. The trees taken up on the college grounds for examination illustrate the point very well. [Plate VI.] The living tree had three main laterally directed roots of this sort. They were vertically flattened for about eight inches and then contracted rather abruptly to two inches in diameter, tapering gradually from this point to their extremities. After leaving the trunk they rose toward the surface and lay for a distance of nineteen feet out from the tree among the roots of clover and grasses. Besides their main roots were a few whip-like roots of the same sort, lying even nearer the surface than the large ones.

The only other roots present were eight small brace roots from one-half to one inch in diameter, which extended downward into the soil at an angle of about 45 degrees. So long as they were uncut the tree stood firmly in place, though the soil was removed for a depth of several feet. The long lateral roots were all cut and still the tree could not be moved until these little roots were severed. The second tree had more of the lateral roots, but they arose and extended outward like those of the first. The brace roots were of the same character and of about the same number.

"Trees with such a root system are adapted to alluvial soils, rich and easily penetrated. A certain amount of moisture is also essential to them. Under natural conditions elms grow among other plants, interspersed with other trees. The ground, besides being rich and from situation moist, is protected during winter by a mulch of dead leaves and in summer by shade and perhaps a tangle of undergrowth. Soil so protected does not give up its moisture quickly. But let such trees be exposed to the heat of the summer sun by cutting away all other trees, or by keeping the grass browsed or mowed closely over their long roots, and they become enfeebled in time and ready to succumb when any sudden and exceptionally severe drought or freeze comes. Even if the removal of our forests had no other effect than exposing the soil to the sun it is probable that such isolated trees would suffer in time. But removal of vast tracts of forest, coupled with tillage and other processes involved in peopling a country, is known to encourage drought in other ways: By favoring a rapid escape of rainfall by surface drainage, a process that is accelerated artificially by ditching, tile draining, and the like, eventually leading to constant late summer droughts from which not only trees but all other plants suffer. A tree with an extensive root system may not show the effect in one year, or in two, but in the course of many years the available food supply becomes exhausted, having been in part leached away by the running waters, and no fresh humus being supplied, the inevitable result is exhaustion for lack of both food and moisture. The effect shows first by the death of tips of branches, the tree not having vitality sufficient to keep up the circulation in the extremities, and the tree becomes 'stag headed,' to use an imported term.

"If one looks about in Bluegrass Kentucky he will see many trees in this condition, oaks, ash and maples. The trouble is of course more or less serious according to the exposure of the roots.

"Not only do trees fail to show signs of suffering immediately after the surface is cleared, but it is known to experienced foresters that for a time they grow more rapidly and appear to be in

better condition. This is explained as the result of an increased food supply, due to the removal of competitors, to a more rapid decomposition of humus, which results from exposure to the air, and to increased sunlight. It is only after a considerable period that the final effect of deforesting is felt by the trees and perceived by man. Such results are not restricted to this country, but are known among foresters the world over.

"I take it we are now witnessing some of these effects in Kentucky, and that our elms feel the change most keenly because of their manner of rooting. The debility brought about by unfavorable conditions such as those described is taken advantage of by the elm tree borer* in some cases, which completes the ruin by girdling trees under the rough outer bark."

PROSPECTS OF CONTINUANCE

There is nothing more characteristic of unusual outbreaks of insect injury than their temporary character. Altho it seemed in 1884 that the elms of central Illinois towns would probably all be gone in a few years, their epidemic disease diminished in the following years almost as rapidly as it had developed. Single cases were still to be found ten years later, but many of the affected trees recovered, and there has been, until lately, only an occasional trace of this special trouble in that part of the state since 1895.

In Kentucky also the heavy loss of elms which was the occasion of the bulletin of Professor Garman quoted above has now practically ceased; and in a letter dated June 3, 1910, he says: "Our elms have largely recovered since my bulletin was written, altho a good many of them were lost during the excessively dry period of which the bulletin treated. During the past three years we have had more rainfall than we wanted at times, and the trees everywhere are looking fine."

The case is therefore not as hopeless as it now looks, for the elms of southern Illinois towns, altho the past summer has been a peculiarly trying one. If the weather of the next years is normally moist, it is quite possible that many of the injured trees favorably situated may recover, and that the general condition of the elms thruout the country will become greatly improved. If, however, weather conditions should continue unfavorable, the injury will go on in all probability to still greater extremes. In any event methods of prevention and remedy are important to all who value their

"*Two other beetles belonging to the same family as the elm borer, were reared by me [Garman] some years ago from diseased elms. They are *Dularius brevilineus* and *Xylotrechus colonus*."

trees, especially as the causes of the present trouble are to be found in great measure in previous mismanagement.

REMEDY AND PREVENTION

The truth is that our shade trees have commonly been treated as if, unlike any other crop we raise, they needed neither care nor cultivation, but once set out would take care of themselves forever. This is not true, as we now know, for even forest trees growing under native conditions; and it is peculiarly false for trees planted in more or less unnatural situations, and for those whose original surroundings have been changed materially for the worse. Here especially the elm must be watched and cared for; fed, watered, and protected; relieved from the attacks of its insect enemies, and surgically treated to heal the wounds they have made. The amount of attention it will require will vary, of course, with its situation, including the condition of other trees on adjacent premises. Indeed, no really satisfactory program of protection and maintenance can be worked out except by cooperation of all concerned. A single badly infested tree, kept because of the indifference of its owner, may be a constant menace to all the other elms in its neighborhood, however intelligently they may be cared for.

The main effort must be at first to supply to endangered trees, and especially to those beginning to fail, the water and plant food, a lack of which is the most serious feature of their situation. Well-rotted stable manure spread generously around the tree as far as its roots extend, with an occasional free watering of the soil during periods of severe drouth, will meet these requirements. If the manure can be left during dry periods as a mulch, the chances of the tree will be greatly improved. The watering must not be a mere surface sprinkling, but should soak the ground to a depth of several inches.

When it is necessary to trim a tree, superfluous branches should be cut or sawed smoothly away at their very beginning. To cut or hack them off irregularly, leaving projecting stubs to dry up and decay, is simply to invite the attacks of borers by offering them a favorable place of deposit for their eggs. For the same reason dead, dying, or badly injured limbs should be promptly cut out and burned.

This is as good a place as any to enter an emphatic protest against the practice of topping or pollarding trees like the elm, not only because their natural beauty is forever destroyed by the process, but also because the tree is peculiarly exposed by it to fatal infestation by its most destructive insect enemies.

Further protection against borers may be given by a thick coat of paint applied to cut surfaces and repeated after the first coat is dry. Any paint will do which is made of linseed oil and lead. Ordinary ready-made paints are nearly useless for this purpose, since they are likely to crack and scale off. As a general preventive of borer infestation, the trunk of the tree and the larger branches may be painted with a mixture intended to prevent the laying of the eggs. Some of the mixtures recommended are prepared as follows: To a gallon of soft soap add half a gallon of hot water and a pint of crude carbolic acid, or a half pint of the refined acid, stirring the latter thoroly in and leaving the mixture over night. Then dilute with eight gallons of water and apply with a whitewash brush. Or, to a saturated solution of washing soda add soft soap to make a thick paint, and stir in a pint of crude carbolic acid and half a pound of Paris green to each ten gallons of the wash. Or, in six gallons of a saturated solution of washing soda dissolve a gallon of soft soap, add a pint of carbolic acid, mixing well, slake enough lime in four gallons of water to form a thick whitewash as it is added to the foregoing, and finally stir in thoroly a half pound of Paris green. One or the other of these substances should be applied, as frequently as may be necessary to keep the bark moist, from the middle of May to the end of July.

THE INSECTS CHIEFLY CONCERNED

Of all the many insect enemies to the elm in Illinois, much the most destructive is the "round-headed" borer commonly known to entomologists as the elm-borer (*Saperda tridentata*). Even more abundant than this, but less injurious, is a much smaller burrowing grub, the larva of the reddish elm snout-beetle (*Magdalis armicollis*). It is the common elm-borer, working in the bark and the sap-wood of the elm, to which the present condition of our dead or dying trees is most commonly attributed by those searching for a cause. It is a common belief, however—difficult to prove, it is true, and at best a matter of intelligent opinion—that this beetle attacks by preference trees already suffering from some disease or other crippling condition. It would be easier to make sure that this is true if it were not for the fact that it is difficult to detect the beginnings of injury by this insect. Often the first notice one has of its presence is a general failure of the tree, due to an infestation already extensive and long continued; and whether this failure began before the borer injury or was caused by it, one can not positively tell. This is, indeed, a matter of little practical importance, since one must proceed in the same way whichever view he takes. That the elm *snout-beetle* infests dying trees in prefer-

ence to healthy ones, can not be doubted, for the larva is abundant in the dead wood of a dying tree but occurs very rarely in the living tissue.

THE ELM-BORER

Saperda tridentata Oliv.

In the larval or boring stage this elm insect may be readily recognized by those at all familiar with the round-headed borer of the apple, because of the close resemblance of the two. They belong, in fact, to nearly related species of the same genus.

Fig. 1. The Elm-borer, *Saperda tridentata*, larva. (Enlarged 5 diameters.)

The full-grown boring larva (Fig. 1) is a footless grub a little over an inch in length, white or yellowish white, thickest in front, and with the head only about half as wide as the first segment behind it. The body is slightly flattened from above downward, with a rather pronounced fold along the sides. The first segment is

about twice as broad as long, and has upon its upper surface a pale, horny, oblong, transverse shield or cover about two thirds as long as wide. This is roughened on the posterior half, but is elsewhere smooth. On the upper side of each remaining segment is an ovate, roughened, transverse area, slightly convex in front and slightly concave behind.

The pupa, which may be found in a cell beneath the bark, is yellowish white, about half an inch long, and with slender antennæ lying along each side and bent forward over the breast.

Fig. 2. Adult, or beetle, of the Elm-borer, *Saperda tridentata*. (Enlarged 4 diameters.)

The parent beetle (Fig. 2) is of a grayish color, due to a very fine gray down which densely clothes the surface. On each side of the thorax and on each wing cover is a submarginal reddish or yellowish stripe, and from each of these stripes three oblique bands project inward and backward to a variable distance in different specimens. Sometimes they extend across the wing cover to meet the corresponding bands on the opposite side, and sometimes they are short oblique branches only. There are often two black spots on each side of the thorax, and three on each wing cover.

Strangely enough, the life history of this abundant insect has never been worked out, but there is good reason to suppose that it extends over two or three years. Indeed, in the northern part of the area of distribution of the species, as many as three distin-

guishable sizes of the larvæ may be found at one time in the mines under the bark, each apparently representing a different generation. The eggs are deposited in June and July and possibly later, as the beetles are abroad until towards the middle of August. The young grub, after hatching, works its way under the bark, making a serpentine burrow as it feeds, which increases in size with the growth of the larva and in course of time may completely girdle the tree. When the larvæ are full-grown they change to the pupa in the early part of the year, and the beetles begin to appear in May.*

This species has been recorded from Vermont, Canada, and Wisconsin, to Pennsylvania, Kentucky, Illinois, and Iowa. It seems to have a general distribution thruout the northeastern United States.

THE REDDISH ELM SNOUT-BEETLE

Magdalis armicollis Say

A small boring grub about a quarter of an inch long or less, frequently associated with the round-headed borer of the elm often occurs in immense numbers in the recently dead wood of the elm,

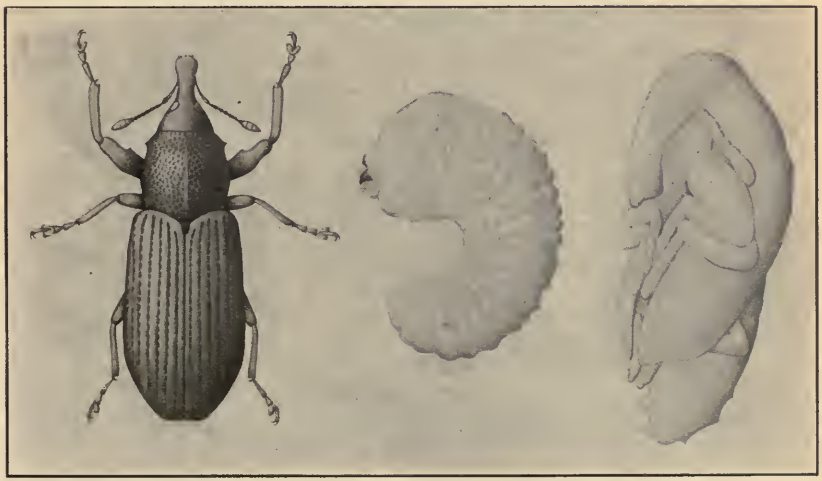

Fig. 3. Elm Snout-beetle, *Magdalis armicollis*: larva, pupa, and adult beetle. (Enlarged 8 diameters.)

and sometimes extends its burrows into the still living tissue adjacent. It is a small, plump, entirely footless, whitish grub, lying partly curled up in the usual grub fashion when at rest. The head is small, but the three segments back of the head are noticeably

*My office collections of the beetles range from May 19 to August 8.

swollen and about one twelfth of an inch thick. The remainder of the body is more slender, slightly tapering to the smoothly rounded posterior end. The head is pale brown, and the mandibles and the narrow front border of the clypeus are dark, in decided contrast with the labrum, which is whitish. The first segment back of the head is faintly brownish, shining except for a dull pubescent ridge along the hind border. The remaining segments, except those near the posterior end, which are smoother, bear two such dull ridges. On the abdominal segments these ridges extend to the spiracles on each side, and behind them is an additional shorter ridge of similar appearance. The folds beneath the head are also dull pubescent.

Fig. 4. Elm twig with bark cut away to show burrow of *Magdalis armicollis*. (Enlarged 3 diameters.)

The beetles, which develop beneath the bark and escape from it by eating small round holes to the surface, are from an eighth to a quarter of an inch in length, the sexes differing to such an extent that they were originally described as separate species. The male is, in fact, decidedly smaller than the female, darker beneath, and with a much more marked contrast in color between the wing covers and the thorax. The wing covers are yellowish, or pale reddish brown, and are each marked with nine deep longitudinal, coarsely punctured, grooves. The thorax and the head are decidedly darker, especially in the male, in which they are frequently black. The thorax is narrower than the wing covers, broadly rounded laterally and very densely punctured above and on the sides, with a more or less evident smooth median raised line. The body beneath is pale reddish brown in the female, and black in the male. The projecting, slightly curved snout is about as long as the thorax, and bears the antennæ near its tip.

The larvæ pupate in spring within the tree, and the beetles emerge in about three weeks, pairing and laying their eggs in May and June.

PLATE I.

ELM-TREE --DIED DURING SUMMER OF 1911. NORMAL SCHOOL CAMPUS, CARBONDALE, SEPTEMBER 20, 1911.

PLATE II.

ELM-TREE—DIED DURING SUMMER OF 1911. NORMAL AVENUE, CARBONDALE, SEPTEMBER 20, 1911.

PLATE III.

ELM-TREE—DIED DURING SUMMER OF 1911. NORMAL AVENUE, CARBONDALE, SEPTEMBER 20, 1911.

PLATE IV.

A DISEASED ELM GROWING ON THE GROUNDS OF THE KENTUCKY STATE UNIVERSITY. PHOTOGRAPHED AUGUST 28, 1899. (FROM PROF. H. GARMAN.)

PLATE V.

ROOTS OF DISEASED WHITE ELM SEEN FROM BENEATH. (FROM PROF. H. GARMAN.)

PLATE VI.

ROOTING HABIT OF ELM, FROM SAME TREE AS FIG. 4: A, B, C, THE THREE MAIN LATERAL ROOTS; D, CONTINUATION OF ROOT C; E, EXTREMITY OF SAME ROOT, 19 FEET FROM THE TRUNK. (FROM PROF. H. GARMAN.)

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